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ABSTRACT

The viability of Freeman's Recursive Adjustment Model as a management tool for explaining and predicting enrollments and the job market is examined using macro and micro cases. To establish a relationship between college attendance and the college job market, Freeman employed a 3-equation model to analyze the causative supply and demand determinants. Freeman's equations and published and unpublished data are used to ascertain the goodness of fit for the entire United States, the entire state of Oregon, the University of Oregon, and two major departments at the University of Oregon (business and psychology). Freeman's model is presented, its application is discussed, and the method utilized to test Freeman's model is described. The study results suggest that Freeman's model for explaining college enrollments and graduate job market could be effectively employed by university administrators and institutional researchers to help analyze the major determinants in college attendance. The model might be more valid for the larger macro entities, such as national, state, or university, than it is for the smaller micro entities. The study results indicate that the degree of fit for the model on the micro level will vary considerably from university department to university department and on the general availability of the required data. (SC)

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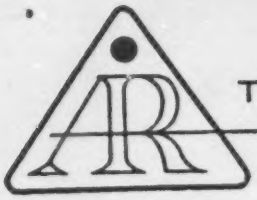

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REPLICATING FREEMAN'S RECURSIVE ADJUSTMENT MODEL OF DEMAND FOR HIGHER EDUCATION

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ABSTRACT

During the 1950s and 1960s, most colleges and universities enjoyed rapid student enrollment increases and liberally expanded their programs and physical facilities accordingly. But the economic, fiscal, and social developments of the 1970s have reduced income sources, increased costs, and diminished student populations. Richard Freeman's work on the demand for higher education and the future worth of a college degree has become a major source of controversy among academicians. To establish a relationship between college attendance and the college job market, Freeman employed a 3-equation model to analyze the causative supply and demand determinants. In this paper, we examine the viability of Freeman's Recursive Adjustment Model as a management tool for explaining and predicting enrollments and the job market using macro and micro cases.

Background

Richard Freeman's work on the determinants of demand for higher education has raised the blood pressure of many people.[1, 2] Indeed, the mere suggestion or implication that the "American Dream" of climbing the socio-economic ladder through more education has approached its limits is not easily accepted. Bowen tends to dismiss Freeman with assertions that higher education is good for most people.[3] He suggests that its economic and social benefits are so great that everyone ought to have at least four years of post secondary education.

Levin criticizes Freeman for suggesting that college does not have much economic return for the individual and that the value of a college education is declining.[4] Stampen joins Levin by suggesting that Freeman's calculations, comparing the salaries of high school and college graduates, are based on a misuse of data.[5] For example, they say that Freeman compared the starting salaries of college graduates with the average earnings of all full-time high school graduates, including older and more senior workers. Levin (1977) also asserts that Freeman failed to take account of the "large and apparently rising gap in unemployment" between high school and college graduates, thus causing the earnings of high school graduates to be overstated and making college graduates look comparatively worse. Stampen (1977) further questions Freeman's use of recent recession-stagflation years for his calculations and his assumption that this would be the pattern for the indefinite future.

These critics miss some of Freeman's major points:

(1) The major determinants in college attendance are economic and demographic.

(2) With the exception of medical education (which is controlled by the American Medical Association), the Cobb-Douglas production function of continuing imbalance in supply and demand is a good explanation of enrollments in higher education.

(3) Perhaps Freeman's model forms a better predictive model than others for

enrollment projections.

We are not aware of any attempts to replicate or validate Freeman's Recursive Adjustment Model of demand for higher education.[6] In this paper, we intend to use Freeman's equations along with published and unpublished data to ascertain the goodness of fit for:[7]

- the entire United States
- the entire State of Oregon
- the University of Oregon, and finally
- two major departments at the University of Oregon (Business and Psychology)

Limitations

Freeman began his work with studies of engineering enrollments and thus limited his analysis to male students. He later expanded his study to include all male college students working toward bachelor's degrees in the United States. In this paper, we too will limit our study to male students wherever possible.

The Model

Freeman's (1976, pp. 207-212) three-equation Recursive Adjustment Model has been successfully tested and used at the Massachusetts Institute of Technology Center for Policy Alternatives for analyzing the supply and demand factors in the college-level professions.[7] This model is presented below:

- The supply of freshmen to college (period covered: 1951 to 1973)

$$FRSH = a_1 + b_1 POP + c_1 (CSAL - ASAL) + d_1 FRSH(-1) \quad (1)$$

- The dependence of graduates on the number of freshmen (period covered: 1954 to 1973)

$$BA = a_2 + b_2 FRSH(-4) + c_2 FRSH(-5) \quad (2)$$

- The determination of college graduate starting salaries (period covered: 1951 to 1973)

$$CSAL = a_3 + b_3 BA(-1) + c_3 DEM + d_3 ASAL + e_3 CSAL(-1) \quad (3)$$

where FRSH = the number of first-degree, credit-enrolled males

POP = the number of 18- to 19-year-old men

CSAL = a weighted average of college starting salaries in accounting, engineering, general business, and sales and marketing

DEM = an index of demand for college graduates in various industries

BA = the number of male bachelor's graduates

ASAL = the average annual earnings of full-time workers in the U. S.

and the a, b, c, d, and e represent the estimated regression coefficients.

In this model, Freeman only included United States males in variables FRSH, POP, and BA. Women, graduate students, and foreign students were not considered. All variables appearing in equations (1), (2), and (3) are in logarithmic form which follows from a linear transformation of the Cobb-Douglas production function. The numbers in parentheses after variables refer to the time lag for the variable, with (-4), for example, reflecting a four-year lag. Freeman (1976, p. 209) notes that the years chosen for the regressions were dictated by data availability, with the immediate post-World War II period deleted from consideration to avoid spurious results caused by extraordinary enrollments from the "backlog" of demand from the war and the G. I. Bill.

Equation (1) is the basic supply equation of the model, linking the number of men enrolling in the first year of college to the relevant population and to the differential between the income of starting male college workers and all fully employed workers in the society. Equation (2) simply relates the number of bachelor's graduates in a given year to the number of freshmen 4 and 5 years earlier. Equation (3) makes the starting salaries of college graduates a function of the number graduating, the index of demand for college graduates, and alternative salaries in the economy. According to Freeman (1976, p. 211), the three equations form a recursive system which is particularly amenable to forecasting. Even though the model is small, relying on few variables and

thus perhaps ignoring some potentially important aspects of the world, Freeman argues that the model suffices in indicating possible future developments.

In his discussion of the Recursive Adjustment Model, Freeman (1976, pp. 52-62) outlines four major factors that determine the dynamic functioning of the college job market. The first factor is the responsive supply behavior on the part of young students. If the behavior of the young is highly sensitive to such economic incentives as salaries and job opportunities, the number of new graduates will be an important homeostatic device helping to equilibrate the job market. If it is not, equilibration will be more difficult, and the major brunt of adjustment will then fall on salaries and employers possibly lending to extended disequilibria in the job market over long periods of time.

The second factor affecting the college job market is the long working life of 40 years or so for most people. Given that the vast majority of college graduates chose their specialties many years ago, the total supply of graduates in the job market becomes relatively inelastic even when the supply of the young is highly adaptive to new circumstances. Because of different activities, graduates of different ages may only be partially substitutable for one another, leading to more or less separate labor markets.

The third factor affecting the college job market is the demand for college graduates and employer behavior. The demand for graduates is dependent on such basic economic forces as the structure of the economy, industrial changes in technology and activities, the possibility of substituting college graduates for other workers or machines, and demographic changes.

The fourth and final major factor affecting the dynamic functioning of the college job market is cobweb dynamics. Because four or more years are required to produce a college graduate, the supply of graduates is determined by market conditions several periods earlier. Given the fixed time delay in

educational production, the supply of graduates is a lagging function of the state of the market. This is similar to the classic cobweb feedback system associated with the markets for corn or hogs. Such a structure generates oscillatory ups and downs with shortages changing into surpluses every 4 or 5 years. The market for university faculty and graduate students is exceptionally vulnerable to changes in the growth of college enrollments. As the number of students levels off, the demand for new faculty will fall rapidly causing a decline in the number of students considering academic careers which further reduces the demand for new faculty. The opposite effect would be true if the number of graduate students were to increase.

In his analysis, Freeman (1976, pp. 184-187) concludes that the unprecedented downturn of the 1970s in the college job market was caused by slackened growth of demand due to reduced expansion of industries that employ many college-trained workers and the reduction of federal government spending in defense and the space program. This downturn occurred when record numbers of college graduates were showing up on the job market. In response to the depressed market, the proportion of young men enrolling in college dropped substantially, thus adversely affecting college enrollments. The decline in the college market was most severe in the teaching and research positions and least in the professional and business-oriented specialties. Graduates in medicine, engineering, and business fared reasonably well in the falling job market. Despite the market downturn, black college graduates and some women graduates managed better than most as a result of affirmative action programs. Federal policies and spending were major contributors to the sixties boom and the seventies bust. Although the income and occupational attainment of college graduates began falling in the 1970s, college-trained workers continued to have higher salary earnings and better prospects than their high school peers. In some instances, the relative surplus of college-trained workers has made it

more difficult for high school workers to obtain positions. Using the Recursive Adjustment Model of the college job market, Freeman forecasts that the economic position of new male bachelor's degree holders is likely to remain depressed in the 1970s, will improve moderately in the early 1980s and rapidly in the later 1980s, although not to the boom conditions of the 1960s.

Method Used to Test Freeman's Model: Oregon as a Test Case

The data used to validate Freeman's Recursive Adjustment Model for the 23-year period, 1951 to 1973, consisted of United States national, State of Oregon, and University of Oregon published and unpublished census and college enrollment data.[7] Following Freeman's example, industrial categories taken from the 1960 U. S. Census were used in determining demand for college graduates in the work force. These categories included agriculture and forestry, mining, construction, manufacturing, transportation and public utilities, wholesale and retail trade, finance and real estate, business and repair services, personal services, entertainment and recreational services, professional services, and public administration. From this data, the effective demand for persons having 4 or more years of college was 9.72% for men and 7.93% for women. These percentages were applied to the total U. S. work force each year to determine the number of college graduates in the work force.

Other national, state, and university data that were used as input into the model included freshmen class enrollments, bachelor's degrees awarded, the consumer price index, average annual earnings of all full-time workers, and average annual starting salaries for college graduates with bachelor's degrees.[7] To determine college graduate starting salaries, Freeman (1976, p. 208) assigned weights of 0.05 to accounting, 0.35 to engineering, 0.20 to general business trainees, and 0.40 to sales and marketing (the weights sum to 1.00). The two University of Oregon major departments used to ascertain the goodness

of fit for Freeman's equations were the College of Business Administration and the Department of Psychology. Because department enrollment data for freshman classes by sex were unavailable for all of the academic years between 1951-52 through 1973-74, total freshman class enrollments were used and determined by dividing senior class enrollments 3 years hence by the decimal fraction, 0.55. This fraction represents the proportion of entering freshmen that eventually receive bachelor's degrees as determined by the Oregon Department of Higher Education from historical data.

During the 23-year period, 1951-52 through 1973-74, both the number of freshmen enrolled and the bachelor's degrees awarded in Oregon colleges and universities increased significantly showing a general upward trend. Freshman class enrollments did show declines from the previous year in 1951-52, 1952-53, 1953-54, 1956-57, and 1973-74, as did the number of bachelor's degrees awarded in 1954-55 and 1960-61. The number of bachelor's degrees awarded in the University of Oregon's College of Business Administration exhibited an up-and-down pattern for the period; whereas, the number of bachelor's degrees awarded in the Department of Psychology experienced an up-and-down movement through 1962-63 and then a significant upward pattern through 1973-74.

To utilize the data collected as input for Freeman's model, a two-step computer program was designed. The first step consisted of a FORTRAN program to determine the demand for college graduates in the work force, the weighted average of college starting salaries, and the "lagged" values for freshman class enrollments and bachelor's degrees awarded. All data were converted into logarithms and used as input into the second step of the computer-assisted analysis: an SPSS (Statistical Package for the Social Sciences) program. The 3-equation Freeman model was executed by calling the REGRESSION procedure in SPSS.[8] The results of this analysis are discussed below.

Analysis of the Results

In examining Freeman's 3-equation Recursive Adjustment Model for determining the supply and demand variables in college-level professions and the job market for college graduates, three "macro" and two "micro" scenarios were considered. The three macro scenarios included the entire United States (National), the entire State of Oregon (State), and the entire University of Oregon (University). The two micro scenarios included the University of Oregon College of Business Administration and the University of Oregon Department of Psychology. From this classification, it can be seen that the macro scenarios consisted of the larger educational systems (i.e. national, state, and university), and the micro scenarios consisted of the subsets or departments of the University of Oregon (i.e. the College of Business Administration and the Department of Psychology). It should be noted that Freeman validated his model using United States national data, and the macro scenario of the entire United States was an independent attempt to replicate his data and study.

Tables 1, 2, and 3 show the results of the computer analysis for each equation in the Recursive Adjustment Model. For comparison purposes, the results of Freeman's original analysis are included in each table.

Referring to Table 1, it can be seen that for equation (1) the coefficient of determination, r^2, is high (0.848 or more) not only for Freeman's scenario but also for the three macro and two micro scenarios considered in this study. Since r^2 is a measure of how well the data "fit" the model or the "goodness of fit", it can be said that for equation (1), most of the variation in male freshman class (total freshman class for the micro scenarios) enrollments can be attributed to or explained by the number of 18- to 19-year-olds in the United States, the difference between college starting salaries and the average earnings of full-time workers, and the number of male freshmen during the previous year. Furthermore, the large values of the F statistic suggest that

Table 1: R. B. Freeman's Model of the Job Market for College Graduates, Equation 1 - The Supply of Freshmen Males to College (Period Covered: 1951-73)[a]

$$FRSH = a + b_1 POP + b_2 (CSAL - ASAL) + b_3 FRSH(-1)^{b}$$

Scenario Title	Coefficients a	b_1	b_2	b_3	Statistics r^2	SEE	F
R. B. Freeman[a]	-2.02	0.88 (0.21)	1.31 (0.26)	0.21 (0.16)	0.987	0.049	
Macro Scenarios							
Entire U. S.	-5.44	1.14 (0.33)	0.21 (0.06)	0.24 (0.20)	0.987	0.059	464.00
Entire State of Oregon	-9.76	1.28 (0.37)	0.18 (0.07)	0.37 (0.17)	0.973	0.106	224.90
Entire Univ. of Oregon	-0.88	0.37 (0.21)	0.20 (0.09)	0.53 (0.19)	0.903	0.118	59.23
Micro Scenarios							
Univ. of Oregon Business Admin.	-1.04	0.63 (0.20)	-0.098 (0.077)	0.47 (0.18)	0.848	0.119	35.33
Univ. of Oregon Dept. of Psych.	-13.64	1.83 (0.49)	0.29 (0.10)	0.45 (0.13)	0.978	0.153	292.42

a. Source: Richard B. Freeman, The Overeducated American (New York: The Academic Press, 1976), pp. 207-212.

b. Symbols: FRSH = The number of first-degree, credit-enrolled males. For the micro scenarios, this also includes females.

POP = The number of 18- to 19-year-old men in the United States.

CSAL = A weighted average of college starting salaries in accounting, engineering, general business, and sales and marketing.

ASAL = Average annual earnings of full-time workers in the U. S.

Numbers in parentheses below b_1, b_2, and b_3 are standard errors.

SEE = The standard error of the estimate.

Table 2: R.B. Freeman's Model of the Job Market for College Graduates, Equation 2 - The Dependence of Graduates on Freshmen (Period Covered: 1954-73)[a]

$$BA = a + b_1 FRSH(-4) + b_2 FRSH(-5)$$ [b]

Scenario Title	Coefficients a	b_1	b_2	Statistics r^2	SEE	F
R. B. Freeman[a]	-0.63	0.71 (0.20)	0.29 (0.20)	0.976	0.061	
Macro Scenarios						
Entire U. S.	-0.13	0.71 (0.16)	0.21 (0.18)	0.976	0.063	344.82
Entire State of Oregon	-0.086	0.66 (0.20)	0.059 (0.22)	0.890	0.128	68.99
Entire Univ. of Oregon	-0.78	0.59 (0.33)	0.48 (0.34)	0.802	0.177	34.38
Micro Scenarios[c]						

a. Source: Richard B. Freeman, The Overeducated American (New York: The Academic Press, 1976), pp. 207-212.

b. Symbols: BA = The number of male bachelor's graduates.
FRSH = The number of first-degree, credit-enrolled males.
SEE = The standard error of the estimate.
Numbers in parentheses after variables in the regression equation (i.e. FRSH) refer to the time lag for the variable in years, with (-4), for example, reflecting a 4-year lag.
Numbers in parentheses below b_1 and b_2 are standard errors.

c. Micro scenarios were not considered because the actual male freshman class enrollment data for the University of Oregon College of Business Administration and the Department of Psychology were unavailable.

Table 3: R.B. Freeman's Model of the Job Market for College Graduates, Equation 3 - The Determination of College Salaries (Period Covered: 1951-73)[a]

$$CSAL = a + b_1 BA(-1) + b_2 DEM + b_3 ASAL + b_4 CSAL(-1)$$ [b]

Scenario Title	Coefficients a	b_1	b_2	b_3	b_4	Statistics r^2	SEE	F
R. B. Freeman[a]	-2.25	-0.15 (0.02)	1.10 (0.51)	0.31 (0.24)	0.45 (0.11)	0.994	0.018	
Macro Scenarios								
Entire U. S.	0.26	-0.078 (0.012)	-0.14 (0.09)	0.66 (0.10)	0.51 (0.08)	0.998	0.009	2436.34
Entire State of Oregon	0.40	-0.066 (0.018)	-0.20 (0.12)	0.66 (0.14)	0.51 (0.11)	0.996	0.012	1368.64
Entire Univ. of Oregon	1.63	-0.038 (0.018)	-0.32 (0.14)	0.62 (0.16)	0.53 (0.13)	0.995	0.014	956.41
Micro Scenarios								
Univ. of Oregon Business Admin.	2.72	-0.011 (0.014)	-0.44 (0.15)	0.59 (0.19)	0.54 (0.15)	0.994	0.015	791.99
Univ. of Oregon Dept. of Psych.	1.33	-0.024 (0.006)	-0.31 (0.11)	0.72 (0.14)	0.45 (0.11)	0.997	0.012	1368.26

a. Source: Richard B. Freeman, The Overeducated American (New York: The Academic Press, 1976), pp. 207-212.

b. Symbols: CSAL = A weighted average of college starting salaries in accounting, engineering, general business, and sales and marketing.

BA = The number of male bachelor's graduates.

DEM = Index of demand for college graduates in various industries.

ASAL = Average annual earnings of full-time workers in the U. S.

SEE = The standard error of the estimate.

Numbers in parentheses after variables in the regression equation (i.e. BA, CSAL) refer to the time lag for the variable in years, with (-1), for example, reflecting a 1-year lag.

Numbers in parentheses below b_1, b_2, b_3, and b_4 are standard errors.

there is a strong linear relationship in equation (1) between the dependent (criterion) variable FRSH and the independent (explanatory) variables POP, CSAL - ASAL, and FRSH(-1).

Looking at Table 2, it can be seen that for equation (2) the coefficient of determination, r^2, is high (0.802 or more) for Freeman's scenario and for the three macro scenarios. Because the actual male freshman class enrollment data for the University of Oregon College of Business Administration and the Department of Psychology were unavailable, the micro scenarios for equation (2) were not considered. As indicated earlier, the number of bachelor's degrees awarded in the College of Business Administration has exhibited an oscillatory pattern during the 23-year period, 1951-52 through 1973-74.[7] This oscillatory up-and-down behavior tends to lend support to Freeman's idea of cobweb dynamics in the college job market.

Table 3 shows that the coefficient of determination, r^2, for equation (3) is very high (0.994 or greater) for Freeman's original scenario and for all of the macro and micro scenarios. This finding strongly suggests that nearly all the variation in college starting salaries can be explained by the number of bachelor's degrees awarded a year earlier, the demand for college graduates in all industries, the average annual earnings of full-time workers in the United States, and college starting salaries one year earlier. The very high F statistic also suggests a strong linear relationship between the dependent and independent variables in equation (3).

Of the three equations that comprise Freeman's model, equation (3) (the determination of college salaries) has the highest coefficient of determination and F statistics followed by equation (1) (the supply of freshmen to college) and then equation (2) (the dependence of bachelor's graduates on the number of freshmen). Also, in general, the r^2 and F statistics tend to be larger for the larger macro entities (i.e. the United States) than for the smaller macro

entities (i.e. the State of Oregon and the University of Oregon). The r^2 for the "Entire United States" was the largest coefficient of determination in all three equations; whereas, the r^2 for the University of Oregon College of Business Administration was the smallest coefficient of determination appearing in equations (1) and (3). This suggests that perhaps Freeman's model might be more valid for the larger macro entities such as national, state, or university, than it is for the smaller micro entities such as various university departments. Two interesting questions that arise are: (1) Should the model be used to establish the micro levels of supply and demand for college graduates with the total level of supply and demand being equal to the sum of the individual micro scenarios, or (2) should the model be used to establish the macro level of supply and demand, say in the State of Oregon, and the micro levels be determined by some kind of "market share" methodologies? Both of these questions are beyond the scope of this paper, but the study results do suggest that the degree of fit for the model on the micro level will vary considerably from university department to university department and on the general availability of the required data.

Conclusion

Freeman has been criticized by other academicians and administrators in higher education as being "overly pessimistic" about the future worth of a college degree and for ignoring the non-economic and social values associated with a college education. Despite these criticisms, we have demonstrated that Freeman's model has the potential for being a useful planning tool for university and college management.

In validating the model to see how well it fit past data, three macro and two micro scenarios were executed. The three macro scenarios included the entire United States (in which Freeman's own scenario was independently repli-

cated), the entire State of Oregon, and the entire University of Oregon in Eugene, Oregon. The two micro scenarios included the University of Oregon College of Business Administration and the Department of Psychology. The results of our study suggest quite convincingly that Freeman's model for explaining college enrollments and graduate job market could be effectively employed by university administrators and institutional researchers to help analyze the major determinants in college attendance.

The Freeman model is simple and consists of three linear regression equations: (1) the supply of freshmen to college, (2) the dependence of bachelor's graduates on the number of freshmen, and (3) the determination of college starting salaries. All of the variables appearing in the equations are in logarithmic form which suggests that the original underlying relationships in their non-linear form approximate the familiar Cobb-Douglas production function.

Further Research Suggestions

Many states budget post secondary public education based on a full-time equivalent (FTE) student-driven model.[9] During periods of rising student enrollments, this model worked fairly well based on enrollment projections calculated from cohort survival rates. However, with the present "accountability kick" and decreasing enrollments at many institutions, the Freeman model is perhaps a better alternative for forecasting student enrollments. The model considers "real world" economic factors which may give university and college administrators a better tool to plan for the future.

Although the results of this study are encouraging, more tests of how well the Freeman model "fits" past data are needed at both the macro and micro levels. For example, would the model fit past data for other state universities and colleges in Oregon or other states? A final question relates to how well the model forecasts 1 or 2 years ahead and its ability to predict and explain surges and declines in enrollments and turning points in the future.

NOTES

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2. See for example R.B. Freeman, A cobweb model of the supply and starting salary of new engineers. Industrial labor relations review. January 1976; R.B. Freeman and J.H. Hollomon, The declining value of college going. Educational digest. Vol. 41, December 1975, 14-18; R.B. Freeman, Does it pay to go to college? U.S. news and world report. Vol. 82, 24 January 1977, 59-60; and R.B. Freeman, Overinvestment in college training? Journal of human resources. Summer 1975, 287-311.

3. H.K. Bowen, Investment in learning: the individual and social value of american higher education. San Francisco: Jossey-Bass, 1977. Also see M.M. Chambers, The worth of higher education: Howard K. Bowen, noted economist, says it repays dollars three times over, and non-pecuniary returns are much larger. Grapevine. No. 234, December 1977, p. 1491.

4. H.M. Levin, Book reviews. Harvard educational review. Vol. 47, No. 2, May 1977, pp. 226-231.

5. American association of universities and colleges, Memo to the president. Vol. 17, No. 3, 28 October 1977, p. 5.

6. R.B. Freeman, The overeducated american. New York: The Academic Press, 1976

7. Readers who may need all of the figures and their sources are advised to contact the authors and refer to Freeman (1976) cited above in note 6.

8. N.H.Nie, C.H. Hull, J.G. Jenkins, K. Steinbrenner, and D.H. Bent, Statistical package for the social sciences, second ed. New York: McGraw-Hill, 1975.

9. The Oregon Department of Higher Education defines a full-time equivalent (FTE) student as one who is enrolled for 15 quarter-hours as an undergraduate or 12 quarter-hours as a graduate for an academic term.

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